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A NEW RECORD OF *MESOCYCLOPS TENUIS* (MARSH) WITH A DESCRIPTION OF THE MALE (COPEPODA: CYCLOPOIDA)[1]

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Marsh (1910) described *Cyclops tenuis* from Arizona. No published record of the occurrence of *tenuis* in the United States has appeared in the intervening years. Dr. Harry Yeatman, University of the South, Sewanee, Tennessee, informed us by letter that he found *M. tenuis* in a plankton sample taken near Louisville, Kentucky, 9 September 1961. *M. tenuis* has been reported from Panama and the Canal Zone (Marsh 1913, Dodds 1926), El Salvador (Marsh 1931), Brazil (Kiefer 1936b), Paraguay (Lowndes 1934) and Yucatan (Wilson 1936 and Pearse and Wilson 1938). *M. tenuis* has been mentioned in several more papers, but these references are only to the collections of the just-mentioned authors. In none of these papers was the male of *tenuis* described or figured. Thus when several females and mature males were found in some plankton tows made by Dr. Walter Moore, Loyola University, New Orleans, Louisiana, and forwarded to us by Mrs. Mildred S. Wilson, Arctic Health Research Center, Anchorage, Alaska, an opportunity to add to the description of the female and place figures of the male in the literature presented itself.

Specimens have been deposited in the United States National Museum and the National Museum of Canada.

Our figures were made with a camera lucida from dissected specimens in glycerin and undistorted by cover glass pressure.

A widely recognized problem is that of assessing individual variation among the members of a species. Many factors including nutrition, temperature and water turbulence have been demonstrated to affect

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TABLE 1. Measurements of adult female *Mesocyclops tenuis* from Louisiana

	N	Mean	Standard deviation	Standard error	Confidence limit t = 0.9
Ramus length	23	75.8[1]	2.55[1]	.53[1]	± .91[1]
Ramus width	23	21.8	1.28	.27	.46
Length of 3rd segment, endopod, leg 4	22	55.1	2.36	.50	.86
Width of 3rd segment, endopod, leg 4	22	16.0	.99	.21	.36
Length of inner spine, 3rd segment, endopod, leg 4	20	62.8	3.62	.81	1.40
Length of outer spine, 3rd segment, endopod, leg 4	21	27.4	1.35	.30	.51
Genital segment length	23	135.9	6.17	1.29	2.21
Genital segment width	23	102.2	4.95	1.03	1.77

[1] microns

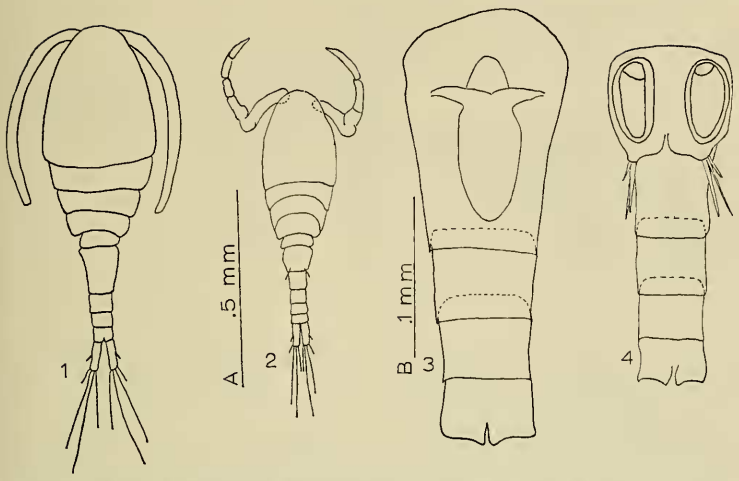
copepod morphology. These factors in conjunction with genetic variability and the fact that populations in different lakes are not freely interbreeding add to variability in morphology. A few freshwater copepodologists have expressed individual variability in terms of ranges of various measurements; however, fewer investigators have used even elementary statistical procedures to help describe variability.

We measured a series of females for those morphological characters which custom and experience have indicated as being helpful in distinguishing species. The animals to be measured were picked at random from the entire sample, the only criterion being that the individuals be adult. Table 1 summarizes our results. Ratios between body parts have been found valuable in some instances; ratios based on confidence limits are therefore included in Table 1.

Female: Total length exclusive of terminal setae about .85 mm (Fig. 1); antennules 17-segmented; ultimate and penultimate segments not bearing any hyaline membrane (Fig. 5); tips of reflexed antennules reaching at least to middle of third and sometimes to posterior border of fourth thoracic segment.

Antenna consisting of 4 segments, terminal bearing 6 setae (Fig. 6); proximal segment bearing 2 setae, longest reaching to distal end of ultimate segment; inner margins of 2nd, 3rd and 4th segments bearing short hairs, some stiff and nearly spinelike; palp of mandible bearing 2 long setae (Fig. 7); blade expanded at tip and bearing many small teeth.

Maxillule consisting of 5 segments (Fig. 8); segment 1 possessing small prominence with 2 setae; segment 2 with long spine arising from inner



Figs. 1–4. *Mesocyclops tenuis* (Marsh), Louisiana, female: 1, dorsal outline of body; 3, genital and abdominal segments in ventral view; male: 2, dorsal outline of body; 4, ventral view of genital and abdominal segments.

distal angle; no crenulations on dorsal surface of segment 2; segment 3 projects into strong spine; segment 4 produced into a strong tooth, accompanied by spine of about equal length; terminal segment bearing 3 spines on inner margin and 2 small aesthetes on outer margin.

Short strong maxilla with palp and several strong teeth (Fig. 9); 4-segmented maxilliped bearing a few strong setae and several fine hairs (Fig. 10).

Posterior corners of all thoracic segments smoothly rounded; segment 5 noticeably narrower than segment 4, a little narrower than anterior margin of genital segment; genital segment longer than wide, ratio of length to width 1.3 to 1.4:1 (Table 1); genital segment about as long as succeeding abdominal segments; receptaculum seminis malleiform (Fig. 3).

Furcal rami about 3.4 to 3.6 times longer than wide (Fig. 11, Table 1); hairs absent on inner margins; lateral seta arises at about middle of ramus; both dorsal and innermost terminal setae longer than ramus; relative lengths of terminal setae of ramus given in Table 2.

Each ramus of four pairs of swimming legs 3-segmented (Figs. 12–15); attenuation noticeable, particularly in terminal segments; spine formula for segment 3 of exopodites is 2, 3, 3, 3; ratio of length to width of endopodite segment 3 of leg 4 is 3.3 to 3.6:1 (Table 3); inner terminal spine of this segment 2.2 to 2.4 times outer and set at definite angle to axis of segment (Fig. 15); segment somewhat shorter than

TABLE 2. Relative lengths of terminal furcal setae of adult female *Mesocyclops tenuis*

	Seta 1 innermost	Seta 2	Seta 3	Seta 4 outermost	Seta 6 dorsal
Arizona (Marsh 1913)	54.5	100	66.7	12.2	12.2
Panama (Coker 1943)	47.5	100	71.5	6.5	38
Brazil (Kiefer 1936b)	47	100	67	12.8	34.2
Louisiana	54	100	65.5	19.4	30.6
Paraguay (Lowndes 1934)	60	100	73	13	40

inner spine; quotient of length of segment to length of spine is .875 (Table 3); leg 5 2-segmented; the inner spiniform seta and outer terminal seta subequal (Fig. 17).

The male is smaller and slenderer than the female; the length is .65 mm (Fig. 2). Evidence that the male described here as *Mesocyclops tenuis* is by association with *M. tenuis* females and thus circumstantial. The close correspondence in form of male and female appendages coupled with the fact that no other mesocyclopid females occurred in the samples make the male identification appear reasonable. The mouth appendages and the antennae are very similar to those of the female. The antennule and its armature are depicted in Fig. 18. The only noticeable difference among the swimming legs of the male and female is the marked elongation of the seta on the outer margin of the basipod of leg 1 of the male, thus only the fourth pair is figured (Fig. 19). The shape of the genital segment and spermatophores is shown in Fig. 4. The spiniform seta of leg 5 seems to be somewhat shorter than the terminal seta (Fig. 20). The sixth leg and genital segment are shown in Fig. 21.

That our specimens are referable to the *tenuis* of Marsh seems highly probable but not absolutely certain. Dr. Thomas E. Bowman, United States National Museum, kindly checked and reported that no *tenuis* are cataloged in their holdings. He further indicated that there might be specimens among the uncataloged portion of the Marsh collections.

That Marsh (1910) was dealing with a mesocyclopid is at once evident from his figure (4) of leg 5 and from his comparison of *tenuis* to *Mesocyclops leuckarti*. Our specimens agree with Marsh's figures and description in the following points: 1) the relative lengths of the seta and the setiform spine on segment 2 of leg 5, shape of the second segment and the position of the setiform spine; 2) the seminal receptacles are similarly shaped; 3) the antennules agree in number of segments and are similar in that segments 3 and 6 are short, 7 is long and 16 and 17 are subequal and relatively long. Furthermore, antennule segments 16 and 17 do not bear a hyaline plate; 4) the relative lengths and widths of the genital segments are similar as are the lengths of the genital segments in relation to the length of the abdomen; 5) the general habituses

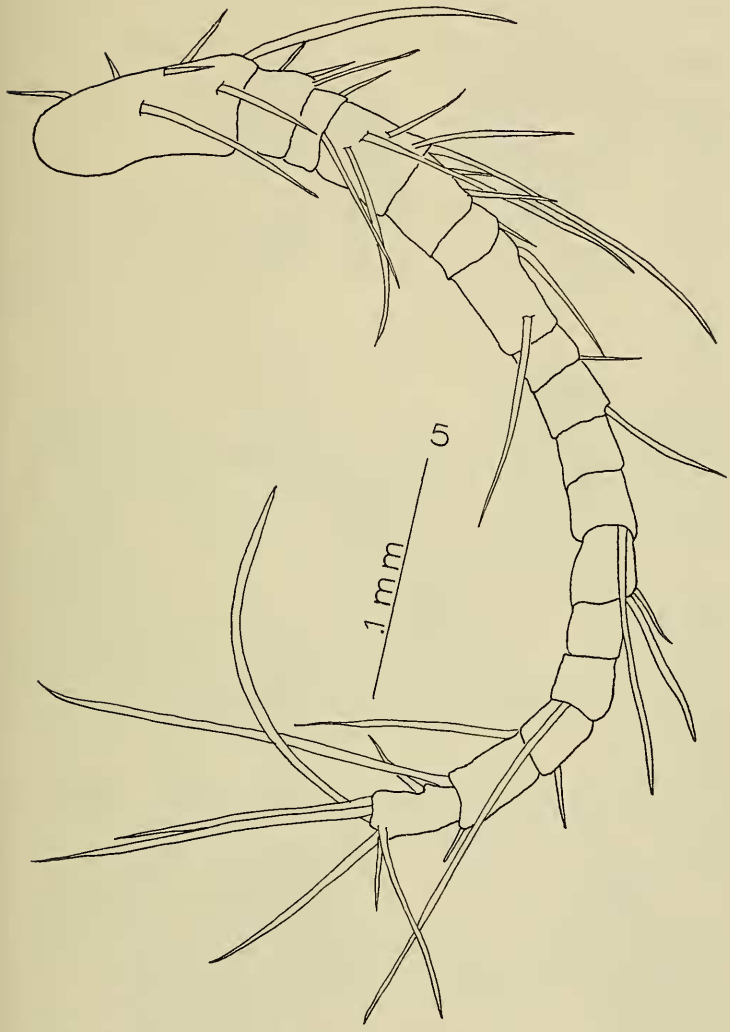


Fig. 5. *Mesocyclops tenuis* (Marsh) female antennule.

are similar, particularly in regard to thoracic segment 5 which is strikingly narrower than either the fourth thoracic or genital segments; 6) the fourth legs are similar in the terminal armature of the endopod and in the generally elongated appearance of all segments of both rami.

More similarities between our specimens and Marsh's *tenuis* can be found by comparing the relative lengths of the terminal setae of the

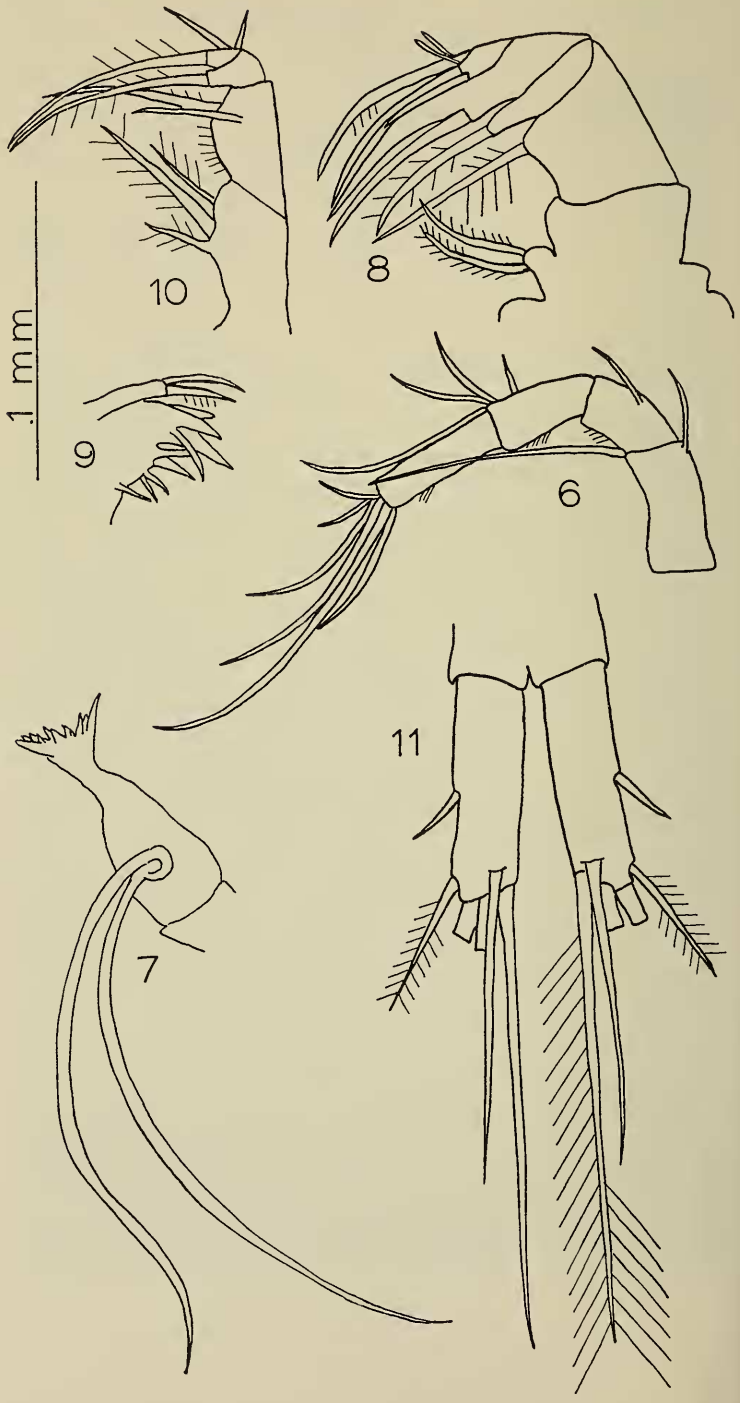

.1 mm
10
8
9
6
7
11

TABLE 3. Morphometric ratios of adult female *Mesocyclops tenuis*

	Genital segment length/ width	Furcal ramus length/ width	Segment 3 endopod leg 4 length/ width	Terminal spines endopod leg 4 inner/ outer	Segment 3 endopod leg 4 segment length/ inner spine
Arizona (Marsh 1910)	1.3–1.4	2.8	–	–	–
Arizona (Marsh 1913)	1.4	–	–	–	–
Panama (Coker 1943)	1.2	3	3.4	1.8	.94
Brazil (Kiefer 1936b)	1.3	3.5	3 –3.7	2.4	.87
Louisiana	1.3–1.4[1]	3.4–3.6[1]	3.3–3.6[1]	2.2–2.4[1]	.875[1]
Paraguay (Lowndes 1934)	1.16	4.5	3.2	1.9	.94

[1] Based on confidence intervals of Table 1.

furcal rami. Marsh (1913: Plate 3, Fig. 12) figures an Arizona specimen together with two from different localities in Panama. Table 2 gives the relative lengths of the terminal seta, using the longest seta (the second from the inner corner) equal to 100. The values were obtained by measuring the setae on drawings by the different authors where figure measurements were not given. The similarity between Marsh's Arizona animals and our Louisiana animals is at once evident.

Marsh never recognized any subdivisions of the genus *Cyclops,* preferring to use this name in the broad sense. Sars (1918) erected the genus *Mesocyclops* for those species of Cyclopidae characterized by a malleiform seminal receptacle; antennules elongated and usually 17-segmented; leg 5 bearing on the distal segment two slender subequal setae.

Both Kiefer (1929, p. 78) and Gurney (1933, p. 286) give the presence of a hyaline membrane on antennule segments 16 and 17 as one of the characteristics of *Mesocyclops.* However, Yeatman (1959, p. 811) indicates in his key that some species may not have such a membrane on the ultimate segment of the antennule. Sewell (1957, p. 97) in his review of *Thermocyclops* mentions that specimens of *M. (T.) schmeili* did not show the membranes reported for *M. (T.) oithonoides, hyalinus, dybowskii, inopinus, minutus* and *tenuis* (quoting Lowndes 1934 on the latter). Sewell further mentions that for other members of *Thermocyclops* he was unable to find any report of such an armature on the antennules.

Kiefer (1927) recognized two subgenera, *Mesocyclops,* in the strict sense, and *Thermocyclops,* based on the position of the setiform spine on leg 5. Kiefer (1928, 1929, 1930) included *tenuis* in *Mesocyclops,* in

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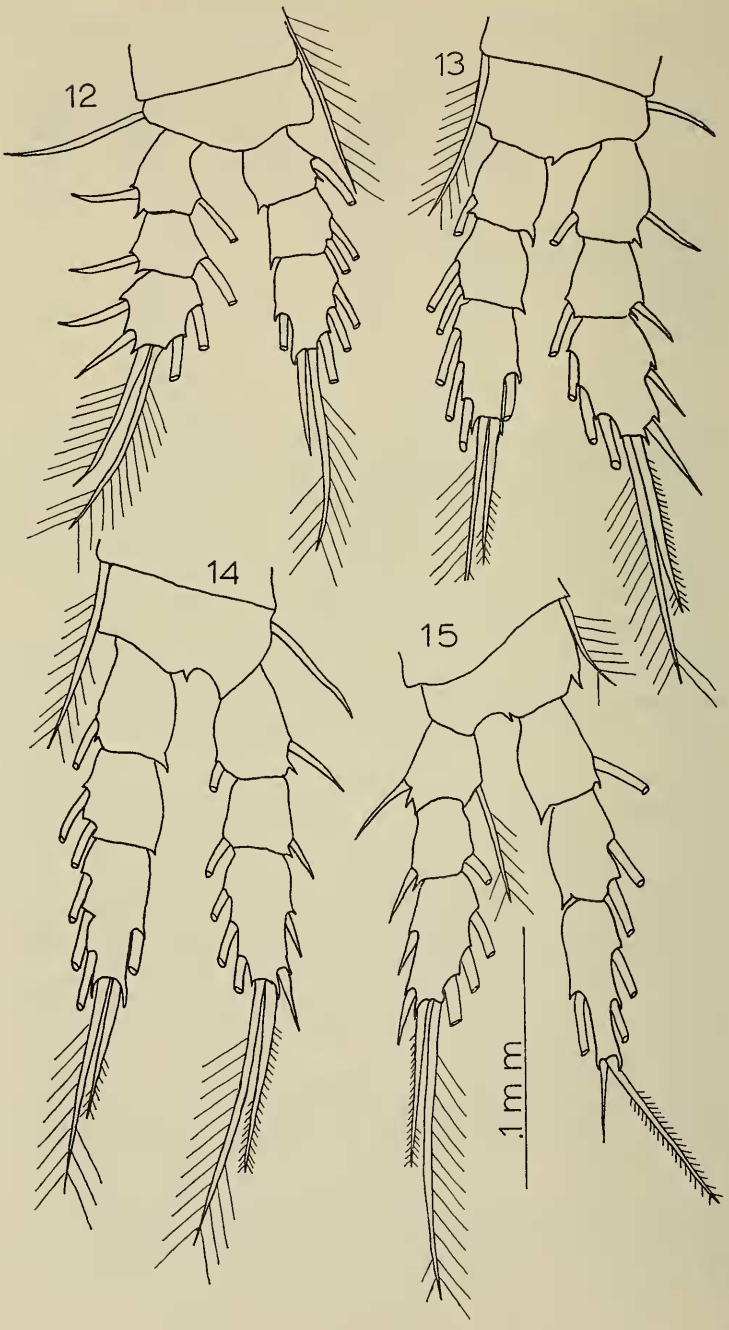
FIGS. 6–11. *Mesocyclops tenuis* (Marsh) female: 6, antenna; 7, mandible; 8, maxillule; 9, maxilla; 10, maxilliped; 11, furcal rami, dorsal view.


12
13
14
15
.1 mm

the strict sense; however, he later (Kiefer 1936a) raised *Thermocyclops* to generic rank and placed *tenuis* in this group. Whether the position of one seta is sufficiently important to separate two genera is a moot point. We agree with Gurney (1933) and Sewell (1957) and regard *Thermocyclops* as a subgenus.

In comparing the Louisiana *tenuis* with described forms of *tenuis* from South and Central America we find that our animals agree with figures and descriptions of Kiefer (1936b) and Coker (1943) and differ from those of Lowndes (1934) (Tables 2 and 3).

One of the most striking differences between our animals and Lowndes' is in the antennule. Lowndes reports a small hyaline plate on segments 16 and 17. We have searched repeatedly for this structure on our specimens and cannot find it. Marsh (1910 and 1913) mentions specifically the absence of a hyaline lamella on *tenuis* and contrasts this to the presence of a plate on *leuckarti.* Coker (1943, p. 192) states that he examined slides of Arizona examples (Marsh's specimens?) and found "indications of a slight hyaline membrane on the two terminal segments of the antenna." He amends Marsh's description to include the possible presence of a poorly-developed membrane. Lowndes states that the antennules reach the hind margin of the second thoracic segment; Marsh states in the original description that the antennule is long "exceeding the second" thorax segment. All Louisiana animals possessed antennules much longer than those reported by Lowndes. The low, unarmed bumps on the connecting plate of the fourth legs (Fig. 16) agree with Kiefer's (1936b) figure and description.

Kiefer (1936b) does not refer to the antennules, thus we cannot determine whether his Brazilian specimens agree with Marsh's specimens or those from Paraguay reported by Lowndes, although he was aware of both Marsh's and Lowndes' papers. Minor discrepancies in relative lengths of terminal setae (Table 2) are inconclusive. However, the presence of the hyaline lamella together with characters of the terminal segment of the endopod of leg 4, proportions of the furcal ramus and of the genital segment (Table 3) and the difference in antennule length lead us to the tentative conclusion that Lowndes' animals may not be referable to *Mesocyclops tenuis* (Marsh). Apparently Marsh found specimens in Panama which he considered identical with *tenuis* from Arizona; however, he noted that some of the Panama animals were much smaller than the northern specimens. After examining Marsh's slides Coker (1943, p. 193) referred at least part of Marsh's animals to *M. inversus* Kiefer. Coker did have specimens from Panama which he considered to be *tenuis* (Figs. 31, 32, 33, p. 189). Kiefer (1936a, p. 133) in describing *Thermocyclops inversus* from Brazil points out that

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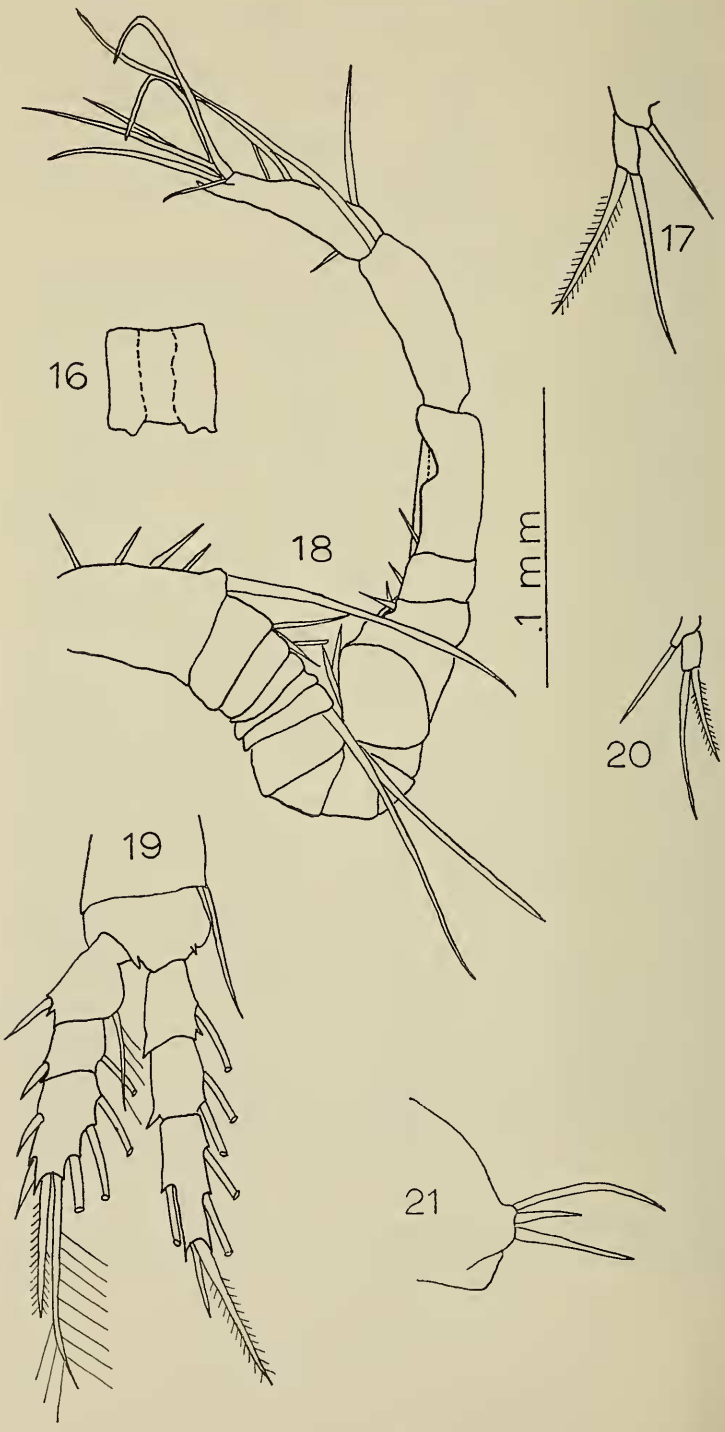
Figs. 12–15. *Mesocyclops tenuis* (Marsh) female swimming legs: 12, leg 1; 13, leg 2; 14, leg 3; 15, leg 4.


17
16
18
1 mm
20
19
21

this species could be confused with *tenuis* but that characters of the fourth leg distinguish the two species.

Little can be said concerning the ecology of *tenuis*. The Louisiana animals were collected from a "shallow pond in stream bed" 10 miles east of Leesville, Louisiana, 25 July 1952. Yeatman's Kentucky animals came from a "sinkhole pond." Lowndes' specimens identifed as *tenuis* came from rain pools in Paraguay. We cannot find any reference by Marsh to the habitat of the Arizona animals. Both Dodds and Marsh reported *tenuis* from a variety of habitats ranging from the open waters of Gatun Lake (Dodds) to small ponds and reservoirs.

In view of possible confusion with other mesocyclopoids the records of *tenuis* in Yucatan cenotes (Wilson 1936 and Pearse and Wilson 1938) must be treated with caution. Coker (1943) examined the El Salvador collection from which Marsh reported *tenuis* and found *inversus*.

In summary, a new record for the occurrence of *Mesocyclops tenuis* Marsh from Louisiana, U.S.A., is reported; additional figures of the female and the first for the male are given. *M. tenuis* seems to be associated with small shallow ponds and is known from Arizona and Louisiana, U.S.A., Panama, Brazil and perhaps Paraguay.

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Figs. 16–21. *Mesocyclops tenuis* (Marsh) female: 16, connecting plate, leg 4; 17, leg 5; male: 18, antennule; 19, leg 4; 20, leg 5; 21, leg 6.

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